Reducing salt consumption by using RWIS and Mesoscale data

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1. Abstract

For today's road authorities it is very important to keep track of the quantity of chemicals used in winter road maintenance. Variations in snow and ice conditions from year to year make it difficult to compare figures. In order to tackle this problem, the Swedish Transport Administration (STA) has developed a Salt Index. This provides a good basis for comparing salt consumption from year to year and a possibility to identify areas where too much salt is used for the prevailing weather conditions.

An analysis of maintenance costs and benefits in total in 2004 showed some interesting results concerning winter maintenance in general and salt consumption in particular.

2. Background

The Swedish Transport Administration (STA) is responsible for winter road maintenance on about 98 100 kilometres of public roads. 18 500 kilometres of these roads are classified as salt roads (AADT more than 1500) and are specially controlled in terms of salt consumption.

In 1991, the Swedish Government made a decision that all road operation and maintenance works undertaken within the state road transportation network were to be contracted through competitive bidding. Since year 2000 100% of such works have been procured on the open market and since 2004 a unit-price payment based on weather data statistics have been used for remuneration in the entire country.

The Salt Index is based on data from our 775 Road Weather Information System (RWIS) stations as well as data provided by the Swedish Meteorological and Hydrological Institute (SMHI) and the total amount of salt used. Basically, we use the former for information on the air and road surface temperatures, humidity and SMHI data for the wind and type and amount of precipitation. The RWIS data is collected every half-hour and the SMHI data every hour. To calculate the amount of precipitation, SMHI uses a model called MESAN, which is an operational Mesoscale Analysis System. This model sub-divides Sweden into a 22 by 22 kilometre grid net, and calculations are performed for each individual grid.

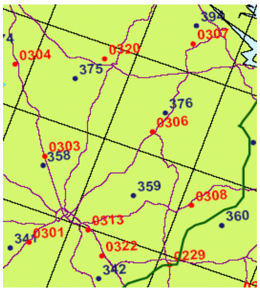

Figure 1: MESAN grids

The winter index provides data on slippery roads, snowfall and snowdrifts expressed in number of occasions; e.g., two icy road surface occasions will be registered if it is known that a skid control measure will be effective for 5 hours, and the RWIS data shows that there still is a risk of slippery roads after 6 hours. The same principle applies to snowfalls and snowdrifts.

The winter index can detect five kinds of slippery surface ranging from light frost to freezing rain,

- Slippery surface due to rain or sleet on a cold road (HN).
- Slippery surface due to damp/wet roads freezing over (HT).
- Slippery surface due to light precipitation (HS).
- Slippery surface due to light frost (HR1).
- Slippery surface due to heavy frost (HR2).

three kinds of snowfall

- 0.3 < d ≤ 1.0
- < d ≤ 2.5
- 2.5 < d.

(d = snow depth in cm)

and snowdrift, from light to heavy.

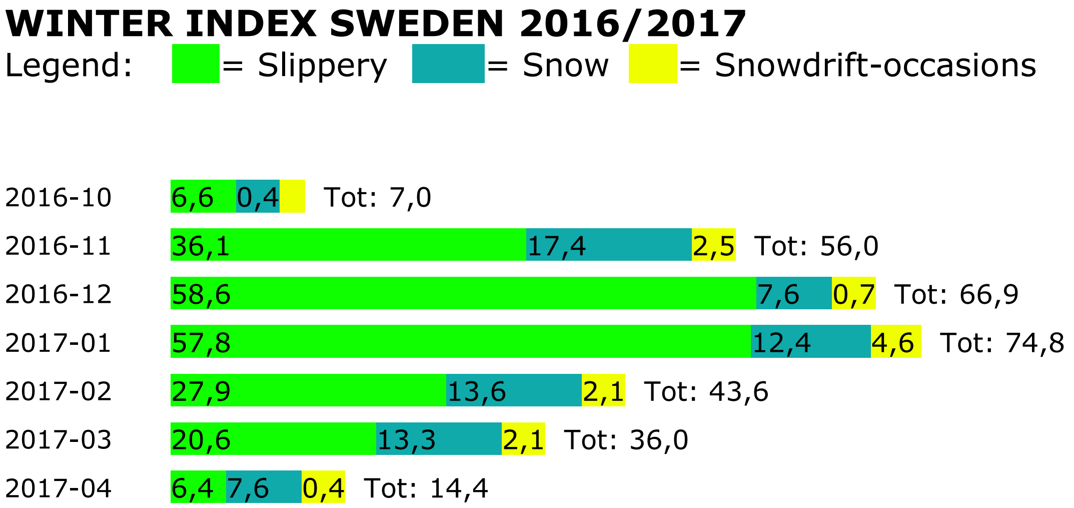

Figure 2: Winter index presented as an average for the entire country

The total number of weather occasions of slippery surfaces, snowfall and snowdrift is calculated for every maintenance area every moth during the winter season.

The amount of material used compared with the weather situation involved is entered in the final step of the calculation.

$$\left(\frac{\left(\dfrac{\sum \text{Salt consumption, kg}}{\sum \text{Length of road salted, km}} \right)}{(\sum \text{HR1} + \text{HS} * 24) + (\sum \text{HR2} * 36) + (\sum \text{HT} * 48) + (\sum \text{HN} * 60) + (\sum \text{SNOW1} * 36) + (\sum \text{SNOW2} * 90) + (\sum \text{SNOW3} * 120)} \right)$$

Figure 3: Calculation of salt index

This provides a good basis for comparing salt consumption from year to year and a possibility to find areas where they use too much salt relative to the weather.

When calculating the Salt Index in this model, the length of road treated with salt, the type of road (standard class) and our “Guidelines for Salt” are used. A Salt Index of 1.0 indicates that the contractor (or county, regional, or national road manager) has used the optimum salt dosage.

SALT INDEX 2016/2017	
Oct-16	1.316
Nov-16	0.579
Dec-16	0.512
Jan-17	0.637
Feb-17	0.606
Mar-17	0.577
Apr-17	0.287
Total:	0.576

SALT INDEX 2004/2005	
Oct-04	0.112
Nov-04	1.174
Dec-04	1.255
Jan-05	1.327
Feb-05	1.306
Mar-05	1.139
Apr-05	0.102
Total:	1.194

Figure 4: Salt index presented as an average for the entire country

3. Objectives

At the beginning of 2004 STA detected that the salt index had started to rise after tending to decrease for several years. In areas with the same local climate and type of roads the differences in salt index were too large to be acceptable. The reason was found to be in the way the contractors were compensated for their maintenance activities.

A salt strategy was then developed to meet new environmental challenges, especially groundwater protection. Earlier tests showed that the use of an incentive based compensation model built on RWiS and MESAN-data instead of a measure based model results in a reduction in the amount of salt used..

Therefore STA changed the whole compensation system for new winter maintenance contacts starting in 2004 to achieve a salt index close to 1.0 in every maintenance area and the environmental goals presented in the salt strategy.

4. The Future

In combination with the Salt and winter indexes STA also has qualification requirements for supervisors and winter maintenance crew to ensure competent winter maintenance operators in order to get safe and effective flow of traffic with low maintenance cost including environmental protection. Every supervisor involved in winter maintenance and all truck drivers using sodium chloride in the maintenance contracts since 2014 have to pass this certification to be approved.

These systems are used as tools for benchmarking maintenance quality and environmental protection.